

CLAIMS

1. A method of forwarding broadcast data packets in a switched data communications network, the network including a plurality of end systems and switches connected by links, the switches having access ports connected to end systems and network ports connected to other switches, and each end system having a unique physical address, the method comprising the steps of:

- a. assigning different virtual LAN identifiers (VLAN-IDs) to different subsets of associated end systems or access ports;
- b. maintaining a first table for mapping the VLAN-IDs to the associated end systems or access ports;
- c. maintaining a second table for mapping the access ports to the associated VLAN-IDs;
- d. when a broadcast packet is received from a source end system at a receiving access port of a first switch:
  - i) reviewing the first table for one or more VLAN-IDs associated with the source end system or receiving access port;
  - ii) encapsulating the packet by adding a header with the associated VLAN-IDs;
  - iii) forwarding the encapsulated packet to all other switches in the network;
  - iv) reviewing the second table for the access ports on the first switch associated with the associated VLAN-IDs and forwarding the broadcast packet out the associated access ports; and
- e. when the encapsulated packet is received at a next switch:
  - i) stripping the header from the encapsulated packet and determining the associated VLAN-IDs;
  - ii) reviewing the second table for the access ports associated with the associated VLAN-IDs; and
  - iii) forwarding the broadcast packet out the associated access ports.

2. The method of claim 1, wherein steps a-c include:  
maintaining a common registry of assigned VLAN-IDs; and

maintaining the first and second tables at each switch.

3. The method of claim 2, wherein steps a-c include:  
registering each end system with the common registry, and returning a list of  
5 assigned VLAN-IDs from the common registry to each switch.

4. The method of claim 2, wherein steps a-c include:  
providing common management of the first and second tables at each switch.

10 5. The method of claim 2, wherein steps a-c include:  
sending a signal from the first switch to the common registry to resolve an  
end system to its assigned VLAN-IDs.

15 6. The method of claim 1, wherein steps a-c include:  
prior to assigning a VLAN-ID to a specific end system, maintaining a default  
VLAN-ID for that specific end system which maps to all access ports.

20 7. The method of claim 1, wherein step d includes:  
maintaining a multicast channel of connections between all switches and  
sending the encapsulated packet on the multicast channel to all other switches in the  
network.

8. The method of claim 7, wherein step d includes:  
maintaining a point-to-multipoint connection from each switch to all other switches in the network.

5 9. The method of claim 7, including:  
providing a network server and maintaining a point-to-point connection between the server and each switch; and  
forwarding all broadcast packets received at the first switch to the network server, the network server performing steps b-d.

10 10. The method of claim 7, wherein each end system is registered with a common registry which programs the multi-cast channel.

15 11. The method of claim 1, wherein steps b-c include:  
maintaining the first and second tables at each switch.

20 12. The method of claim 1, wherein step b includes:  
listening to end systems heard on respective access ports at each switch and maintaining the end systems heard and their respective access ports in the first table at the respective switch.

25 13. The method of claim 1, further comprising:  
assigning reserved VLAN-IDs without limitation as to end system and access port; and  
providing at least one switch which encapsulates the broadcast packet by adding a header with a reserved VLAN-ID, forwarding the encapsulated packet to all other switches, and forwarding the broadcast packet out the access ports on the at least one switch.

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14. The method of claim 1, wherein step b further includes:

listening to end systems heard on respective access ports at each switch and maintaining the end systems heard and their respective access ports in the first table at the respective switch; and

5 upon receipt of a unicast packet for a destination end system unknown to the first switch, completing steps d.i-iv) and e.i) and then at the next switch reviewing the first table for the respective access port for the destination end system and forwarding the packet out the respective access port.

10 15. The method of claim 1, wherein steps b-c include:

maintaining a Management Information Base (MIB) interface at each switch for programming the first and second tables.

16. The method of claim 15, wherein steps b-c include:

15 using a Simple Network Management Protocol (SNMP) set message for maintaining the first and second tables.

17. The method of claim 1, wherein steps b-c include:

20 maintaining a VLAN status table at each switch for enabling and disabling an entire VLAN-ID.

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18. A computer-readable storage medium comprising program instructions for restricting flooding of a data packet, of one of a broadcast, multicast and unknown destination type, in a switched data communications network, the network including a plurality of end systems and switches connected by links, the switches having access ports connected to end  
5 systems and network ports connected to other switches, the program instructions causing the network to:

- a. assign at least one identifier to a respective subset of end systems;
- b. map the at least one assigned identifier to an access port attached to at least one end system in the respective subset of end systems; and
- 10 c. when the data packet is received from a source end system at a receiving access port of a first switch:
  - i) determine one or more identifiers associated with the source end system;
  - ii) encapsulate the data packet by adding a header with the one or more determined identifiers;
  - 15 iii) forward the encapsulated data packet to all or a subset of other switches in the network; and
  - iv) determine if at least one access port other than the receiving access port on the first switch is associated with the one or more determined identifiers and forward the data packet out the at least one determined  
20 access port.

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19. The computer-readable storage medium as recited in claim 18, further comprising instructions to cause the network to:

- d. when the encapsulated data packet is received at a second switch with access ports:
    - 25 i) strip the header from the encapsulated data packet and to determine the one or more encapsulated identifiers in the header of the encapsulated data packet;
    - ii) determine if at least one access port of the second switch is associated with the one or more encapsulated identifiers; and
    - 30 iii) forward the data packet out the at least one determined access port of the second switch.
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4. ~~20.~~ The computer-readable storage medium as recited in claim ~~18~~<sup>1</sup>, further comprising instructions to cause the network to, if in step c(iv) no other access port is determined, discard the data packet.

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5. ~~21.~~ The computer-readable storage medium as recited in claim ~~18~~<sup>1</sup>, further comprising, in step b, instructions to cause the network to:

maintain a first table in each switch to relate the at least one assigned identifier to the end systems or access ports of the respective switch; and

maintain a second table in each switch to relate the access ports of the respective switch to assigned identifiers.

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6. ~~22.~~ The computer-readable storage medium as recited in claim ~~21~~<sup>5</sup>, further comprising, in step c.i), instructions to cause the network to:

review the first table for the one or more identifiers associated with the source end system or the receiving access port.

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7. ~~23.~~ The computer-readable storage medium as recited in claim ~~22~~<sup>6</sup>, further comprising, in step c.iv), instructions to cause the network to:

review the second table for an access port associated with the one or more determined identifiers.

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8. ~~24.~~ The computer-readable storage medium as recited in claim ~~23~~<sup>7</sup>, wherein the assigned identifier is a virtual LAN identifier.

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9. ~~25.~~ The computer-readable storage medium as recited in claim ~~18~~<sup>1</sup>, wherein the received data packet is of a protocol not supported by a protocol-specific call processor in the first switch.

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10. ~~26.~~ The computer-readable storage medium as recited in claim ~~18~~<sup>1</sup>, further comprising instructions to cause the network to:

maintain a common registry of assigned identifiers.

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11. ~~27.~~ The computer-readable storage medium as recited in claim ~~26~~<sup>10</sup>, further comprising instructions to cause the network to:

register each end system or access port with the common registry, and

return a list of assigned identifiers from the common registry to each switch for the end systems or access ports of the respective switch.

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17 ~~28.~~ The computer-readable storage medium as recited in claim ~~18~~, further comprising instructions to cause the network to:

5 maintain the mapping at each switch for the end system or access ports of the respective switch.

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1 ~~29.~~ The computer-readable storage medium as recited in claim ~~26~~, further comprising instructions to cause the network to:

10 send a signal from the first switch to the common registry to resolve an end system or access port to its assigned identifiers.

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11 ~~30.~~ The computer-readable storage medium as recited in claim ~~18~~, further comprising instructions to cause the network to:

15 prior to assigning an identifier to a specific end system or access port, maintain a default identifier for that specific end system or access port which maps to predetermined access ports.

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12 ~~31.~~ The computer-readable storage medium as recited in claim ~~18~~, further comprising instructions to cause the network to:

20 maintain a multicast channel of connections between all or a subset of switches and wherein step c(iii) comprises forwarding the encapsulated packet on the multicast channel.

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1 ~~32.~~ The computer-readable storage medium as recited in claim ~~31~~, wherein the channel includes:

a point-to-multipoint connection from each switch to all other switches in the network.

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25 ~~33.~~ The computer-readable storage medium as recited in claim ~~18~~, further comprising instructions to cause the network, at step c(iii), to provide a distributed service in the switches for forwarding the encapsulated data packet.

18. <sup>18</sup>~~34~~ The computer-readable storage medium as recited in claim <sup>11</sup>~~18~~, further comprising instructions to cause the network to assign the identifier based on a policy work group definition.

5 19. <sup>19</sup>~~35~~ The computer-readable storage medium as recited in claim <sup>1</sup>~~18~~, further comprising instructions to cause the network to:  
maintain at least one mapping table at each switch for performing the mapping step.

10 20. <sup>20</sup>~~36~~ The computer-readable storage medium as recited in claim <sup>19</sup>~~35~~, further comprising instructions to cause the network to:  
listen to end systems heard on respective access ports at each switch and maintain the end systems heard and their respective access ports in the mapping table at the respective switch.

15 21. <sup>21</sup>~~37~~ The computer-readable storage medium as recited in claim <sup>1</sup>~~18~~, further comprising instructions to cause the network to:  
assign a reserved identifier without limitation as to end system and access port.

20 22. <sup>3</sup>~~38~~ The computer-readable storage medium as recited in claim <sup>2</sup>~~19~~, further comprising instructions to cause the network to:  
listen to end systems heard on respective access ports at each switch and to maintain the end systems heard and their respective access ports in a mapping table at the respective switch; and

upon receipt of a unicast packet for a destination end system unknown to the first switch, complete step c for the unicast packet and then at the next switch review the mapping table for the respective access port for the destination end system and forward the packet out the respective access port.

25 22. <sup>22</sup>~~39~~ The computer-readable storage medium as recited in claim <sup>11</sup>~~18~~, further comprising instructions to cause the network to:  
maintain a Management Information Base (MIB) interface at each switch for programming at least one mapping table, the mapping table being used to perform the mapping step.

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40. The computer-readable storage medium as recited in claim 35, further comprising instructions to cause the network to:

use a Simple Network Management Protocol (SNMP) set message to maintain the mapping table at each switch.

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41. The computer-readable storage medium as recited in claim 18, further comprising instructions to cause the network to:

maintain a status table at each switch to enable and disable a respective subset.

42. Computer software, residing on a computer-readable storage medium, comprising instructions for use in a switch in a switched communications network including a plurality of end systems, the computer software for restricting flooding of a data packet selected from the group consisting of a broadcast packet, a multicast packet, and an unknown destination packet of a protocol not supported by a call processor in a switch which receives the data packet, the instructions causing the switch to:

assign at least one identifier to a respective subset of end systems;

map the at least one assigned identifier to an access port of the access switch attached to at least one end system in the respective subset of end systems;

upon receipt of the data packet at the access switch, encapsulate the data packet with the at least one identifier assigned to a source end system of the data packet, to forward the encapsulated packet to all or a subset of other switches in the network, and to send the original data packet to access ports having the at least one identifier; and

upon receipt of the encapsulated packet at a receiving switch, de-encapsulate the packet and to forward the de-encapsulated packet to the access ports having the at least one identifier.

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43. A computer-readable storage medium comprising program instructions for restricting flooding of a data packet, of one of a broadcast, multicast and unknown destination type, in a switch to be used in a switched data communications network, the network to include end systems and switches connected by links, the switches having access ports connected to end systems and network ports connected to other switches, the program instructions causing the switch to:

a. assign at least one identifier to a respective subset of end systems;

- b. map the at least one assigned identifier to an access port attached to at least one end system in the respective subset of end systems; and
- c. when the data packet is received from a source end system at a receiving access port of the switch:

- i) determine one or more identifiers associated with the source end system;
- ii) encapsulate the data packet by adding a header with the one or more determined identifiers;
- iii) forward the encapsulated data packet to all or a subset of other switches in the network; and
- iv) determine if at least one access port other than the receiving access port on the switch is associated with the one or more determined identifiers and forward the data packet out the at least one determined access port.

<sup>26</sup>  
~~44~~ The computer-readable storage medium as recited in claim <sup>25</sup>~~43~~, further comprising instructions to cause the switch to:

- d. when an encapsulated data packet is received:
  - i) strip the header from the encapsulated data packet and determine the one or more encapsulated identifiers in the header of the encapsulated data packet;
  - ii) determine if at least one access port of the switch is associated with the one or more encapsulated identifiers; and
  - iii) forward the data packet out the at least one determined access port of the switch.

<sup>28</sup>  
~~45~~ The computer-readable storage medium as recited in claim <sup>25</sup>~~43~~, further comprising instructions to cause the switch to, if in step c(iv) no other access port is determined, discard the data packet.

<sup>29</sup>  
~~46~~ The computer-readable storage medium as recited in claim <sup>25</sup>~~43~~, further comprising, in step b, instructions to cause the switch to:

maintain a first table to relate the at least one assigned identifier to the end systems or access ports of the switch; and

maintain a second table to relate the access ports of the switch to assigned identifiers.

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37 47. The computer-readable storage medium as recited in claim 29, further comprising, in step c.i), instructions to cause the switch to:

review the first table for the one or more identifiers associated with the source end system or the receiving access port.

5 31 48. The computer-readable storage medium as recited in claim 30, further comprising, in step c.iv), instructions to cause the switch to:

review the second table for an access port associated with the one or more determined identifiers.

32 49. The computer-readable storage medium as recited in claim 31, further comprising instructions to cause the switch to:

prior to assigning an identifier to a specific end system or access port, maintain a default identifier for that specific end system or access port which maps to predetermined access ports.

27 50. The computer-readable storage medium as recited in claim 32, further comprising instructions to cause the switch to:

listen to end systems heard on the access ports and to maintain the end systems heard and their respective access ports in a mapping table.

33 51. The computer-readable storage medium as recited in claim 33, further comprising instructions to cause the switch to:

20 maintain a Management Information Base (MIB) interface.

34 52. The computer-readable storage medium as recited in claim 34, further comprising instructions to cause the switch to:

use a Simple Network Management Protocol (SNMP) message to maintain a mapping table.

35 53. The computer-readable storage medium as recited in claim 35, further comprising instructions to cause the switch to:

maintain a status table to enable and disable a respective subset.